Ecological Transparency and Smartphones

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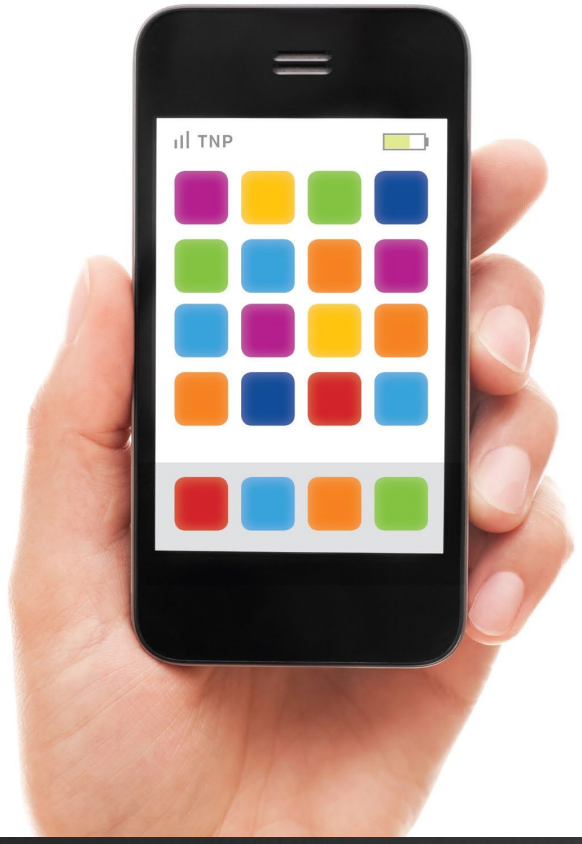
The Smartphone

ANATOMY OF AN INDUSTRY

Elizabeth Woyke

"This book is an eye-opener." —Robert W. McChesney



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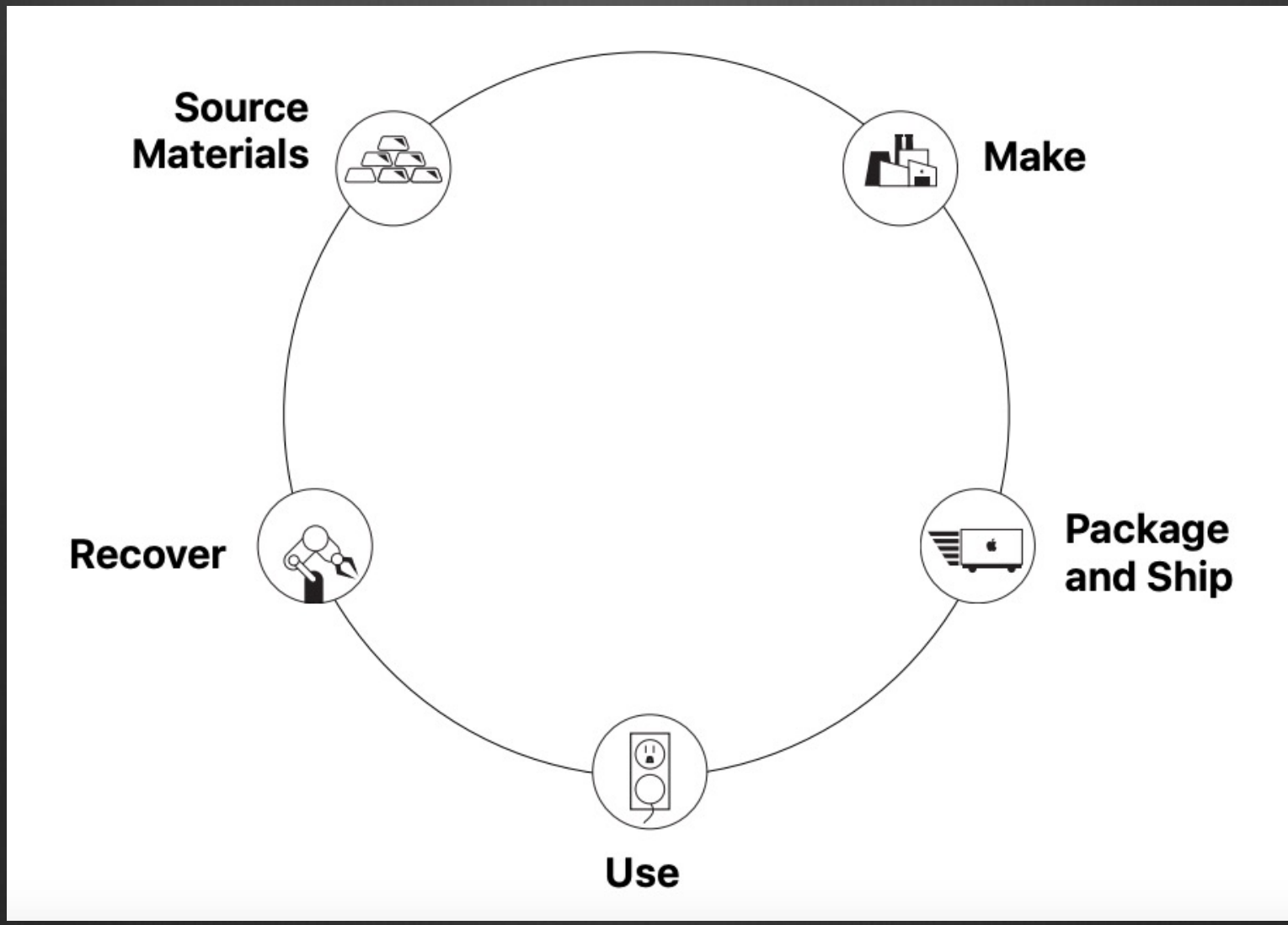
Smartphone lifecycle



Carbon emissions

iPhone 11 Pro Max
(three-year lifecycle)

Production 78%
Transportation 3%
Customer use 18%
Recycling <1%

Total: 86 kg CO2e

Pixel 3 XL
(three-year lifecycle)

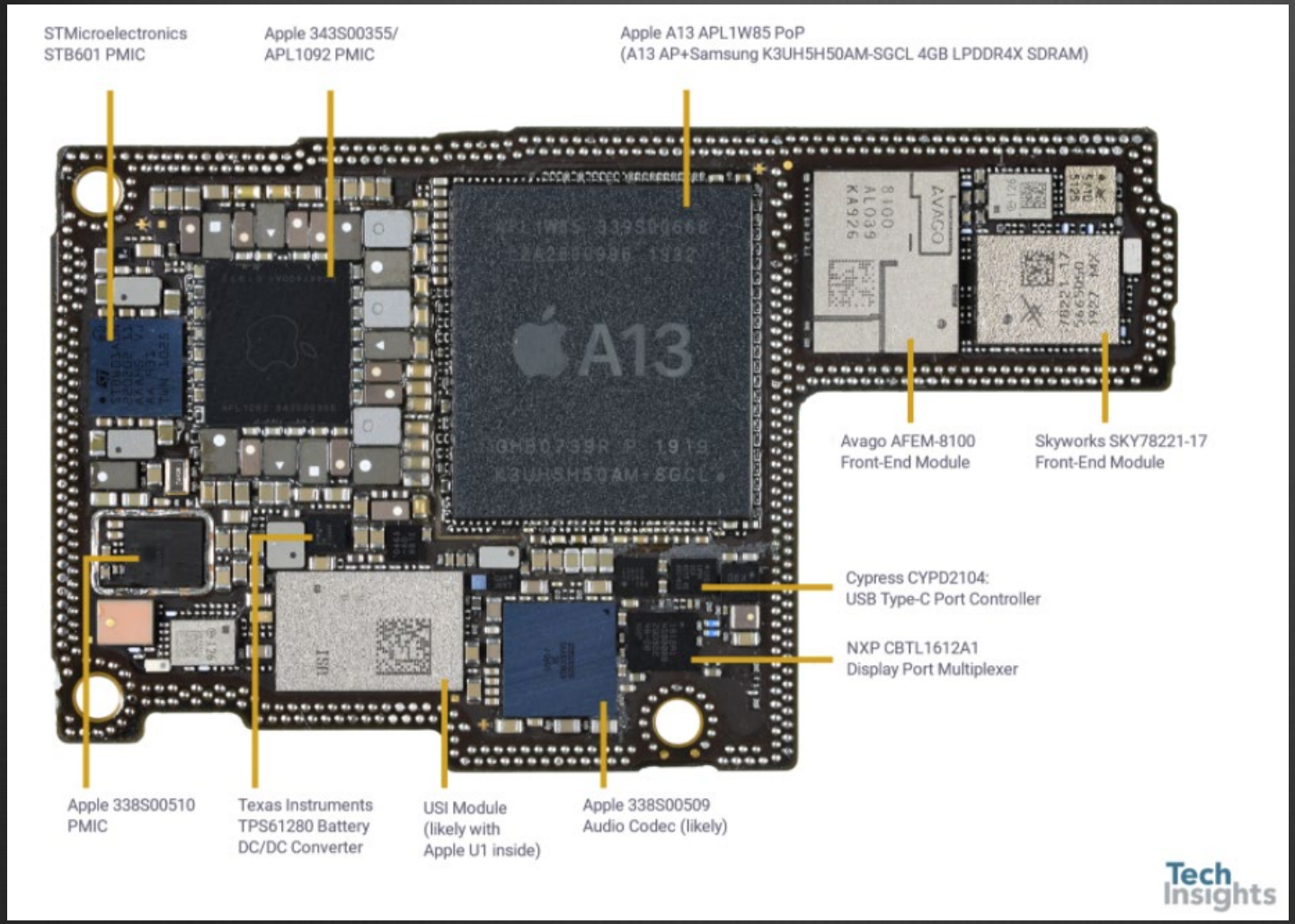
Production 71%
Transportation 6%
Customer use 22%
Recycling 1%

Total: 70 kg CO2e

What's inside a smartphone?

Modules inside an iPhone 11 Pro Max

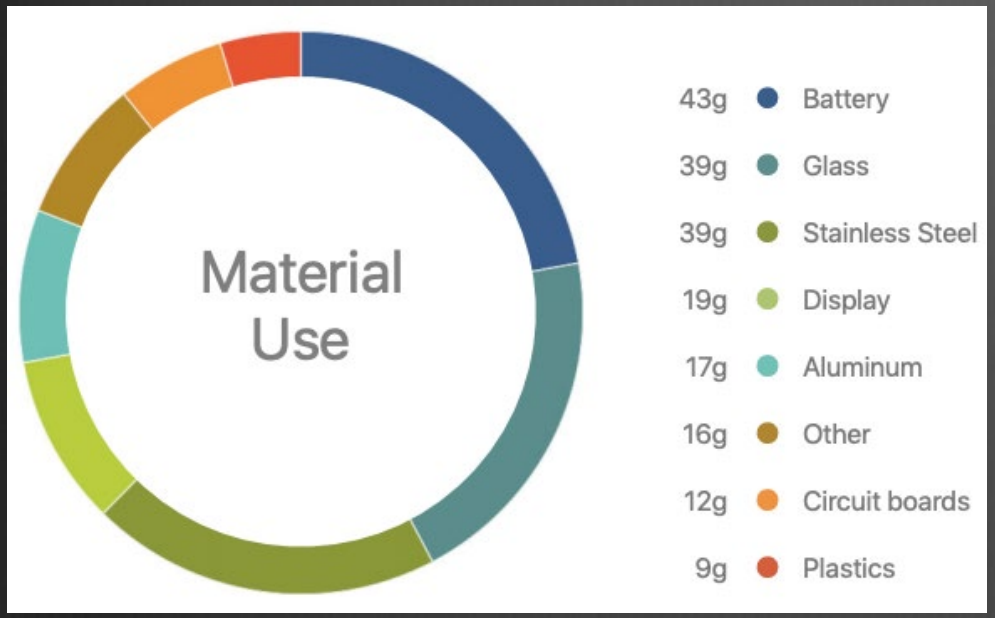
Bill of Material estimates



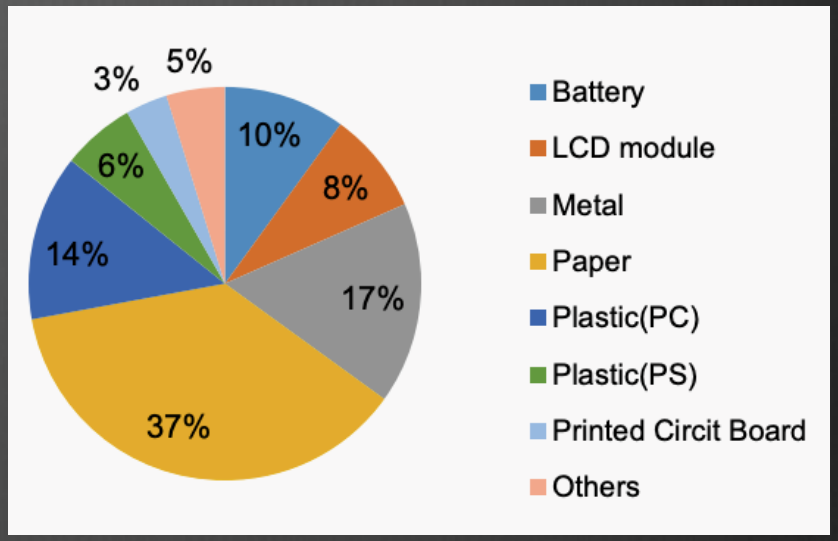
iPhone 11 Pro Max

Applications Processor	$64.00
Baseband Processor	$25.50
Battery	$10.50
Camera / Image	$73.50
Connectivity	$10.50
Display / Touchscreen	$66.50
Memory: Non-Volatile**	$58.00
Memory: Volatile	$11.50
Mixed Signal	$1.50
Non-Electronics	$61.00
Other	$21.00
Power Management / Audio	$10.50
RF Component	$30.00
Sensor	$1.50
Substrates	$16.50
Supporting Materials	$7.50
Final Assembly & Test	$21.00
Total	$490.50

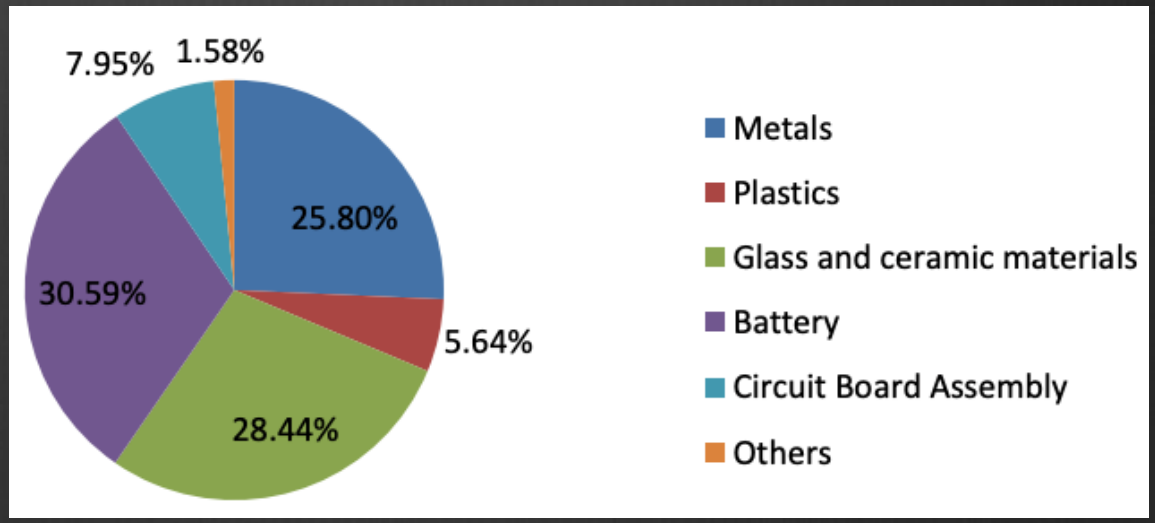
Raw materials (general)



iPhone XR



Samsung Galaxy Note 5



Huawei P30

Raw materials (specific)

Aluminum → phone enclosure

Cobalt → battery

Copper → camera, charging port, circuit board, phone enclosure, receiver, speaker, vibration feedback, wireless charging coil

Gallium → display (LED)

Glass → display, phone back

*Gold → camera, charging port, circuit board, wireless charging coil

Indium → display (touchscreen)

Lithium → battery

*Tantalum → capacitor

*Tin → camera, charging port, circuit board

*Tungsten → vibration feedback

*conflict mineral

Mining tin in Eastern Congo

E-waste flow

Top e-waste producing countries by volume

- China
  USA
  Japan

Top e-waste producing countries per capita

- Norway
  UK
  Denmark

Used smartphones

- 207 million used and refurbished phones shipped worldwide in 2019
- Major destinations: Argentina, Brazil, India, Mexico, the Philippines, Russia, Thailand

E-waste statistics

- 50 million tons in 2018
  52 millions tons by 2021
  120 million tons by 2050

- Personal devices (computers, screens, smartphones, tablets, TVs) = 50% of all e-waste
- "Small IT" devices (mobile phones, tablets, laptops) → 3.9 million tons (2016)

- 20% of e-waste formally recycled
- E-waste = 70% of toxic waste in landfills
- Fastest-growing waste stream globally

Global sales/shipments

Yearly

1.56 billion in 2018

1.54 billion in 2019

Monthly

99.2 million in Feb. 2019

61.8 million in Feb. 2020

[versus 261.2 million laptops in 2019]

Replacement cycle

40 months (2019 – global)

26.2 months
(2018 -- France, Germany, Italy, Spain, UK)

24.7 months
(2018 – USA)

36 months (2025 projection – global)

[versus 4-5 years for a laptop]

International e-waste laws

- Bamako Convention (Africa)

  Entered into force in 1998

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

  Entered into force in 1992

- Ban Amendment (to the Basel Convention)

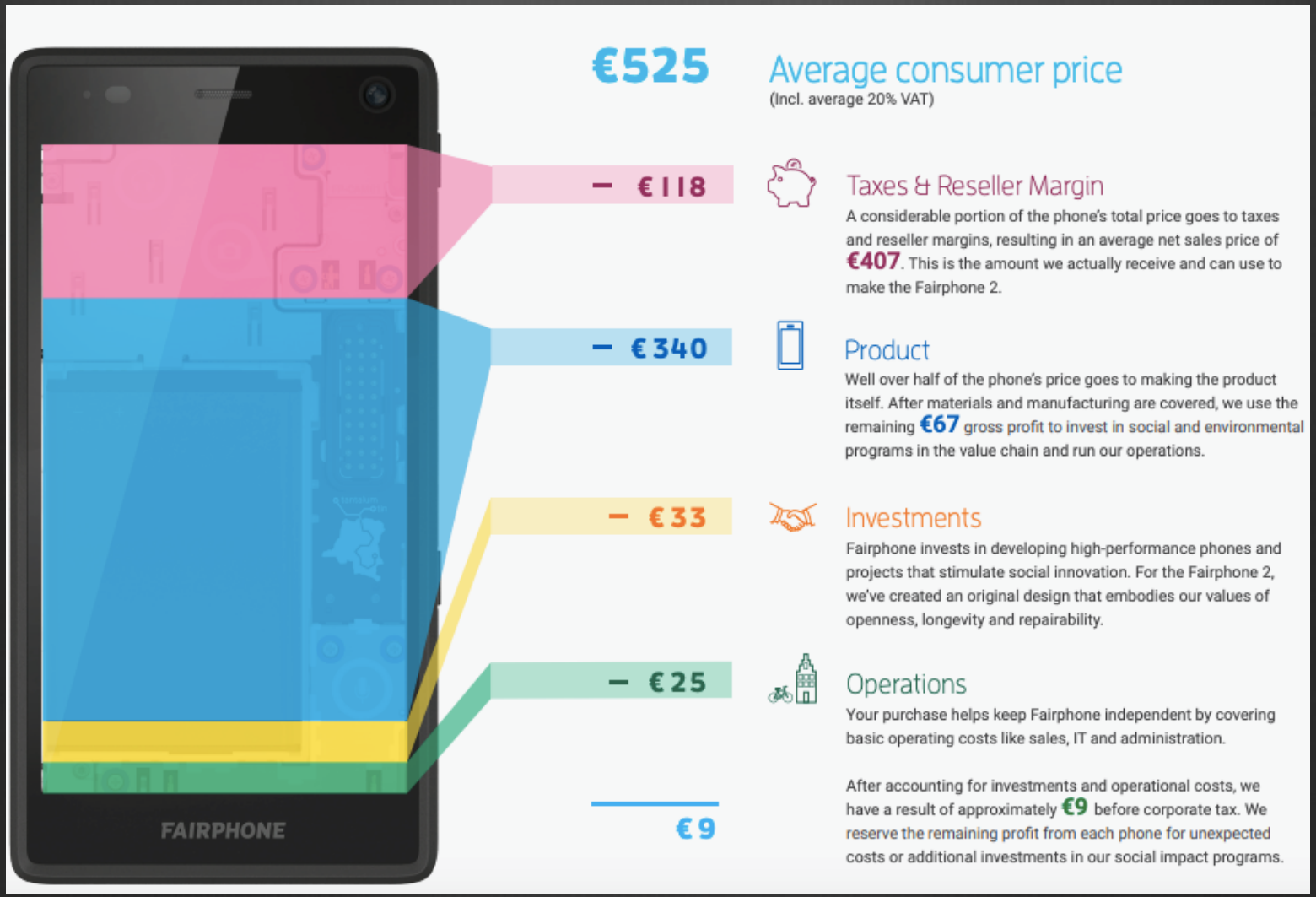
  Entered into force in 2019

What needs to be done?

- Increased consumer education
  - Label smartphones with repairability and green ratings & lifespan estimates
  - Explain recycling best practices and recycling certifications
- Explore new ownership models
  - Multi-year leasing programs (phone makers lease phones to consumers and assume responsibility for repairing and recycling devices)
- Greater accountability for manufacturers and retailers
  - Right to Repair legislation
- Better data about e-waste
  - Updated global numbers, digital tracking of e-waste flow between countries
- Improved automation of e-waste recycling
  - Small-scale, modular, affordable solutions (E-waste Microfactory)

Fairphone

Cost breakdown (Fairphone 2)



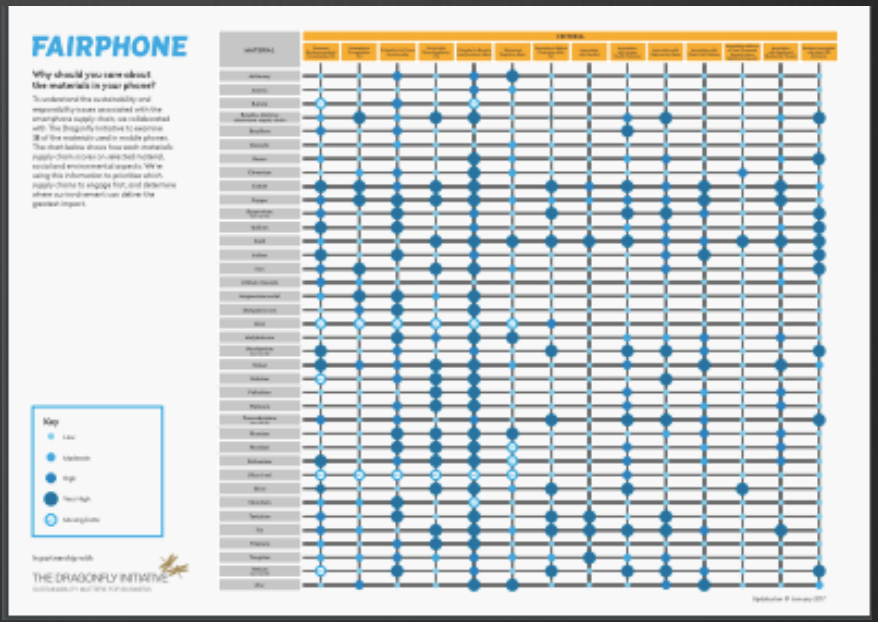
Fairphone

Materials scoping study

MATERIAL	Consumer Electronics Industy Consumption (%)	Smartphone Composition (%)	Criticality for Phone Functionality	End of Life Recycling Rates (%)	Potential to Recycle from Electronic Waste	Estimated Depletion Rate
Antimony						
Arsenic						
Barium	MD				MD	
Bauxite, alumina, aluminium supply chain						

Key

- Low
- Moderate
- High
- Very High
- MD — Missing Data



Fairphone

Interactive supply-chain map

Fairphone

Mapping the tungsten supply chain

Fairphone

All routes lead to Suzhou, China (assembly site)

Data/resources

Phone Makers

- Environmental Responsibility Report / Sustainability Report
- Environmental Report Card (for specific products)
- Supplier Responsibility Report / Supplier Code of Conduct
- List of Suppliers
- Conflict Minerals Policy / Responsible Sourcing of Minerals Policy
- Restricted Substances Specification / Regulated Substances Specification

Third-Party Analysis

- The Global E-Waste Statistics Partnership
- iFixit teardowns
  - iFixit repairability scores
- Bill of Material estimates
  - IHS Markit, TechInsights
- The Restart Project
- Greenpeace Guide to Greener Electronics [not updated since 2017]

Misc.

- Closing the Loop (social enterprise that ships e-waste from Africa to Europe for ethical recycling -- Netherlands)
- Fairphone (smartphones with minimal environmental impact -- Netherlands)
- Shiftphone (modular, easy-to-repair smartphones -- Germany)
- Teracube (modular smartphone with 4-year warranty -- US)